TFT DISPLAY SPECIFICATION

WINSTAR Display Co.,Ltd.

華凌光電股份有限公司

Winstar Display Co., LTD
華凌光電股份有限公司
WEB: https://www.winstar.com.tw E-mail: sales@winstar.com.tw

SPECIFICATION

CUSTOMER : _____

MODULE NO.: WF0096ATYAA3DNF10#

APPROVED BY: **(FOR CUSTOMER USE ONLY)**	**PCB VERSION: DATA:**

SALES BY	APPROVED BY	CHECKED BY	PREPARED BY
			葉虹蘭
ISSUED DATE: 2020/08/05			

TFT Display Inspection Specification: https://www.winstar.com.tw/technology/download.html
Precaution in use of TFT module: https://www.winstar.com.tw/technology/download/declaration.html

Winstar Display Co., LTD 華凌光電股份有限公司	MODLE NO：
RECORDS OF REVISION	**DOC. FIRST ISSUE**

VERSION	DATE	REVISED PAGE NO.	**SUMMARY**
0	2020/06/30		First issue
A	2020/08/05		Add Inspection Specification

Contents

1.Module Classification Information

W	F	0096	A	T	Y	A	A3	D	N	F	1	0#
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬

①	Brand：WINSTAR DISPLAY CORPORATION		
②	Display Type：F→TFT Type, J→Custom TFT		
③	Display Size：009.6” TFT		
④	Model serials no.		
⑤	Backlight Type：	F→CCFL, White S→LED, High Light White	T→LED, White Z→Nichia LED, White
⑥	LCD Polarize Type/ Temperature range/ Gray Scale Inversion Direction	A→Transmissive, N.T, IPS TFT C→Transmissive, N. T, 6:00 ; F→Transmissive, N.T,12:00 ; I→Transmissive, W. T, 6:00 K→Transflective, W.T,12:00 L→Transmissive, W.T,12:00 N→Transmissive, Super W.T, 6:00	Q→Transmissive, Super W.T, 12:00 R→Transmissive, Super W.T, O-TFT V→Transmissive, Super W.T, VA TFT W→Transmissive, Super W.T, IPS TFT X→Transmissive, W.T, VA TFT Y→Transmissive, W.T, IPS TFT Z→Transmissive, W.T, O-TFT
⑦	A：TFT LCD B：TFT+SCREW HOLES+CONTROL BOARD C：TFT+ SCREW HOLES +A/D BOARD D：TFT+ SCREW HOLES +A/D BOARD+CONTROL BOARD E：TFT+ SCREW HOLES +POWER BOARD		F：TFT+CONTROL BOARD G：TFT+ SCREW HOLES H：TFT+D/V BOARD I：TFT+ SCREW HOLES +D/V BOARD J：TFT+POWER BD

⑧ Resolution:

A	128160	B	320234	C	320240	D	480234	E	480272	F	640480
G	800480	H	1024600	I	320480	J	240320	K	800600	L	240400
M	1024768	N	128128	P	1280800	Q	480800	R	640320	S	480128
T	800320	U	8001280	**V**	176220	W	1280398	X	1024250	Y	1920720
Z	800200	2	1024324	3	7201280	4	19201200	5	1366768	6	1280320

⑨ D: Digital L：LVDS M:MIPI

⑩ Interface:

N	Without control board	A	8Bit	B	16Bit	H	HDMI
I	I2C Interface	R	RS232	S	SPI Interface	U	USB

⑪ TS:

N	Without TS	T	Resistive touch panel	C	Capacitive touch panel (G-F-F)
G	Capacitive touch panel (G-G)	C1	Capacitive touch panel (G-F-F)+OCA		
C2	Capacitive touch panel (G-F-F)+OCR	G1	Capacitive touch panel (G-G)+OCA		
G2	Capacitive touch panel (G-G)+OCR	B	CTP+GG+USB		

⑫	Version: X:Raspberry pi	
⑬	Special Code	#:Fit in with ROHS directive regulations

2.Summary

WF0096A is a color active matrix thin film transistor (TFT) liquid crystal empty cell. This model is composed of amorphous silicon TFT as a switching device. It is a transmissive type display operating in the normally black mode.

This TFT LCD has a 0.96-inch diagonally measured active display area with 80 x 160 dot (80 horizontal by 160 vertical pixel) resolution. Each pixel is divided into Red, Green, Blue dots which are arranged in vertical stripes.

3.General Specifications

Item	Dimension	Unit
Size	0.96	inch
Dot Matrix	80 x RGB x 160(TFT)	dots
Module dimension	18.7 (W) x 31.9 (H) x 2.59 (D)	mm
Active area	10.8 x 21.696	mm
Dot pitch	0.135 x 0.1356	mm
LCD type	TFT, Normally black, Transmissive	
Viewing Angle	80/80/80/80	
Aspect Ratio	1:2	
IC	ST7735S or equivalent	
TFT Interface	SPI Interface	
Backlight Type	LED,Normally White	
CTP Interface	I2C	
CTP IC	FT3267 or equivalent	
CTP FW Version	V06	
With /Without TP	With CTP	
Surface	Glare	

*Color tone slight changed by temperature and driving voltage.

4.Absolute Maximum Ratings

Item	Symbol	Min	Typ	Max	Unit
Operating Temperature	TOP	-20	－	+70	℃
Storage Temperature	TST	-30	－	+80	℃

Note: Device is subject to be damaged permanently if stresses beyond those absolute maximum ratings listed above

1. Temp. ≦60℃, 90% RH MAX. Temp.＞60℃, Absolute humidity shall be less than 90% RH at 60℃

5.Electrical Characteristics

5.1. Operating conditions:

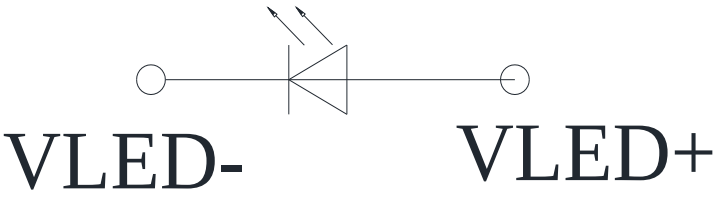
Item	Symbol	Min	Typ	Max	Unit
Supply Voltage	VCC	3.0	3.3	3.6	V
Supply LCM current	ICC	—	2	3	mA
Supply CTP	VDDT	2.8	—	3.3	V
	I_{VDDT}	—	2	3	mA

Note:To avoid power supply noise, please avoid using driving conditions close to min. or max. value

5.2. LED driving conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
LED current	ILED	—	20	—	mA	
LED voltage	VLED	2.8	3.0	3.3	V	Note 1
LED Life Time		—	50000	—	Hr	Note 2,3,4

Note 1 : There are 1 Groups LED

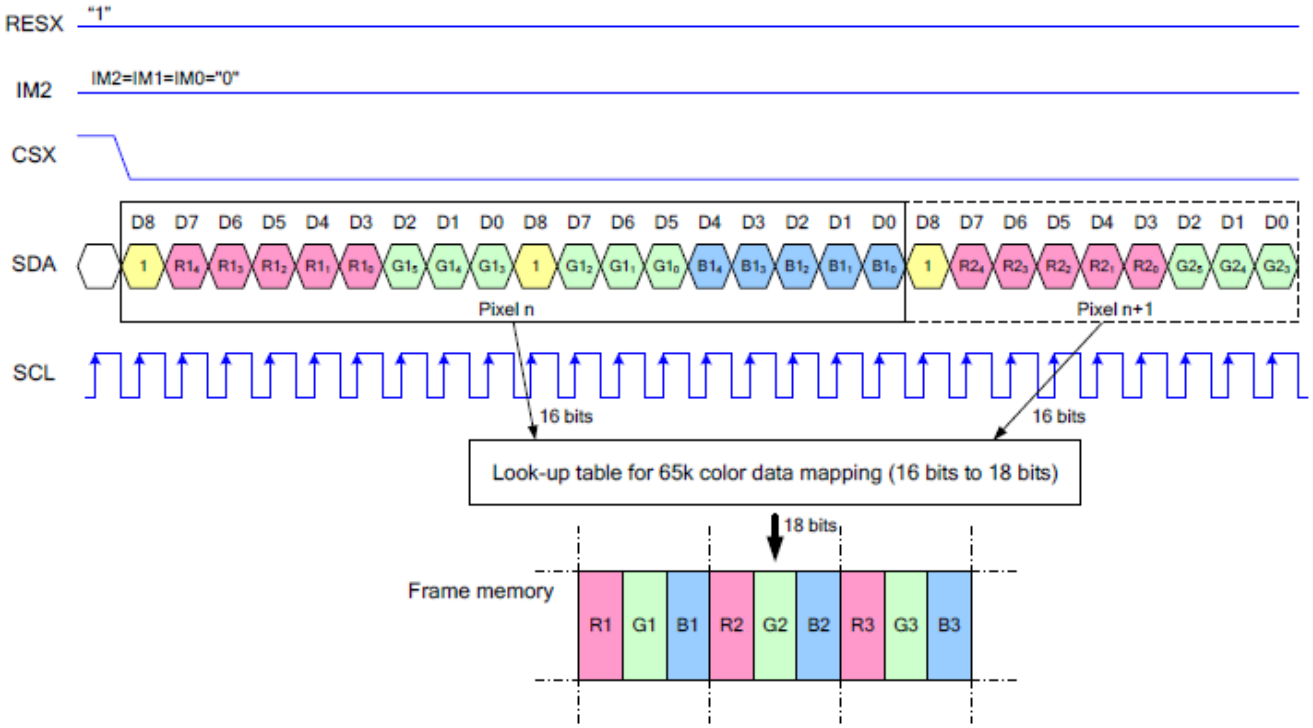


Circuit diagram

Note 2 : Ta = 25 ℃
Note 3 : Brightness to be decreased to 50% of the initial value
Note 4 : The single LED lamp case

6.Data Color Coding

6.1. 3-Wire SPI Mode: RGB 5-6-5-bit Input, 65K-Colors, 3AH="05h"

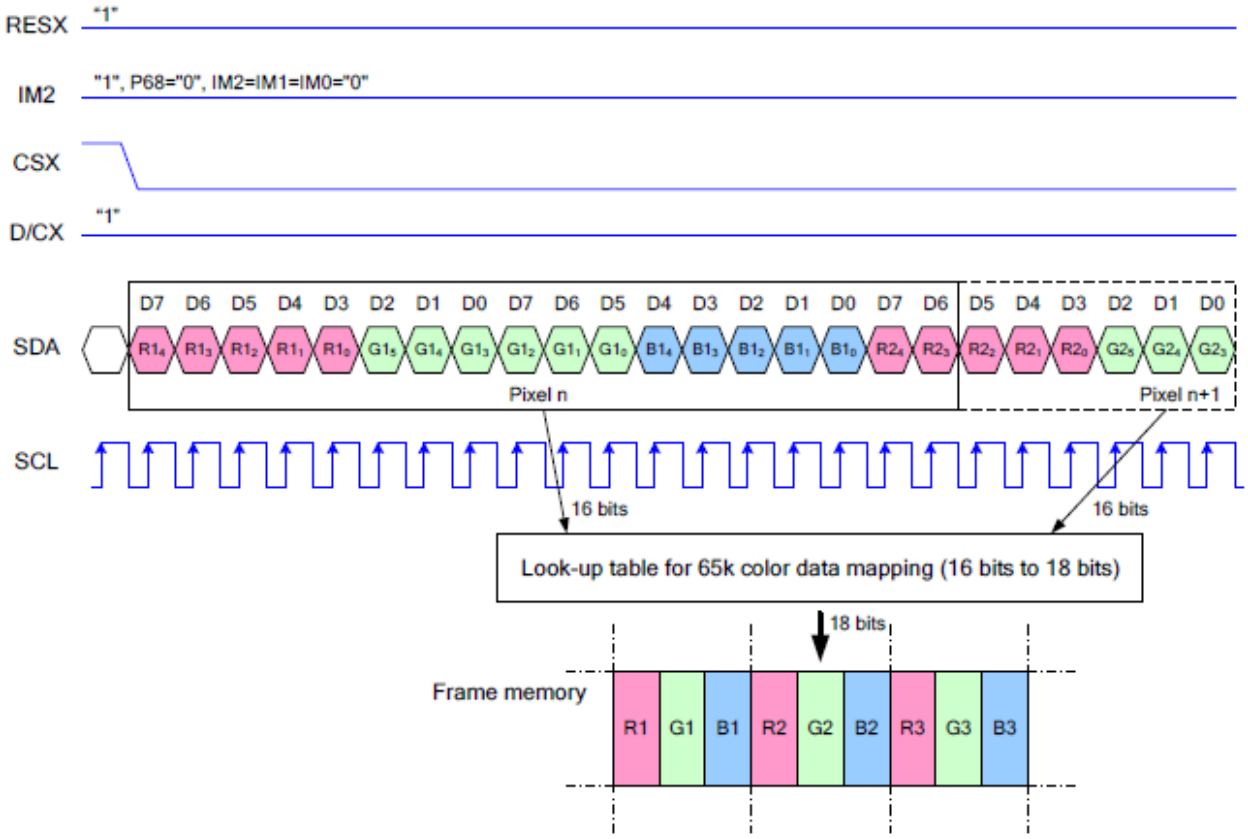


Note 1: Pixel data with the 16-bit color depth information

Note 2: The most significant bits are: Rx4, Gx5 and Bx4

Note 3: The least significant bits are: Rx0, Gx0 and Bx0

6.2. 4-Wire SPI Mode: RGB 5-6-5-bit Input, 65K-Colors, 3AH="05h"

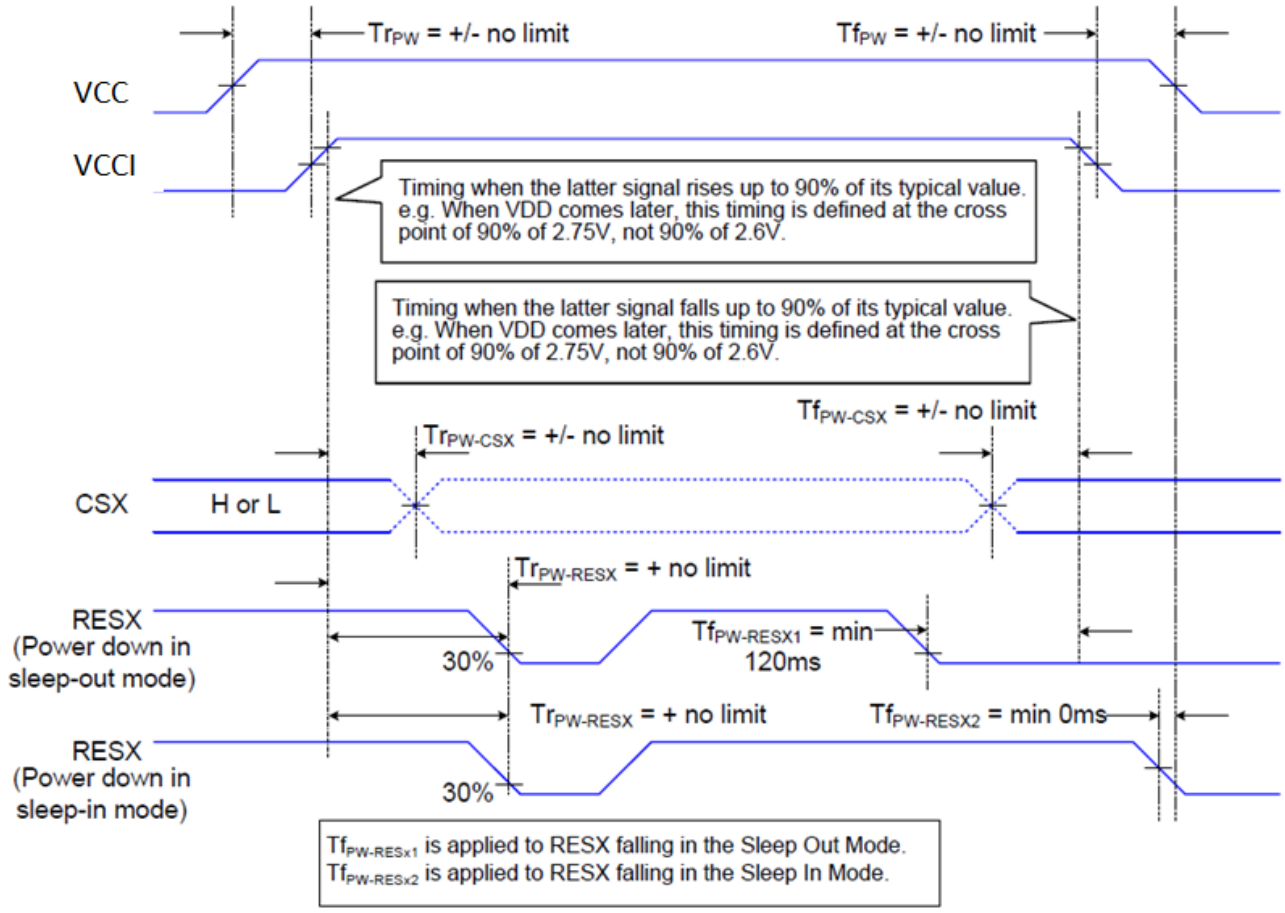


Note 1. Pixel data with the 16-bit color depth information

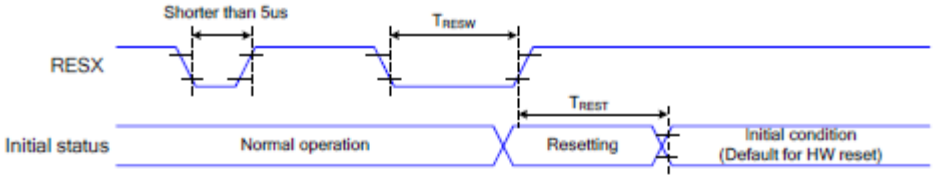
Note 2. The most significant bits are: Rx4, Gx5 and Bx4

Note 3. The least significant bits are: Rx0, Gx0 and Bx0

7.Power ON/OFF Sequence



8.Reset Timing



Related Pins	Symbol	Parameter	MIN	MAX	Unit
RESX	tRESW	Reset Pulse Duration	10	-	us
	tREST	Reset Cancel	-	5	ms
				120	ms

Table 14 Reset Timing

Notes:

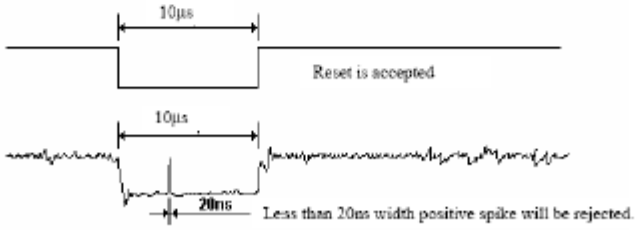
1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (tRT) within 5 ms after a rising edge of RESX.

2. Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below:

RESX Pulse	Action
Shorter than 5us	Reset Rejected
Longer than 9us	Reset
Between 5us and 9us	Reset Starts

3. During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In -mode.) and then return to Default condition for Hardware Reset.

4. Spike Rejection also applies during a valid reset pulse as shown below:



5. When Reset applied during Sleep In Mode.

6. When Reset applied during Sleep Out Mode.

7. It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

9.Optical Characteristics

Item		Symbol	Condition.	Min	Typ.	Max.	Unit	Remark
Response time		Tr	θ=0°、Φ=0°	-	30	40	.ms	Note 3
		Tf						
Contrast ratio		CR	At optimized viewing angle	-	800	-	-	Note 4
Color Chromaticity	White	Wx	θ=0°、Φ=0	0.255	0.305	0.355		Note 2,6,7
		Wy		0.275	0.325	0.375		
Viewing angle	Hor.	ΘR	CR≧10	-	80	-	Deg.	Note 1
		ΘL		-	80	-		
	Ver.	ΦT		-	80	-		
		ΦB		-	80	-		
Brightness		-	-	300	400	-	cd/m^2	Center of display
Uniformity		(U)	-	75	-	-	%	Note 5

Ta=25±2℃

Note 1: Definition of viewing angle range

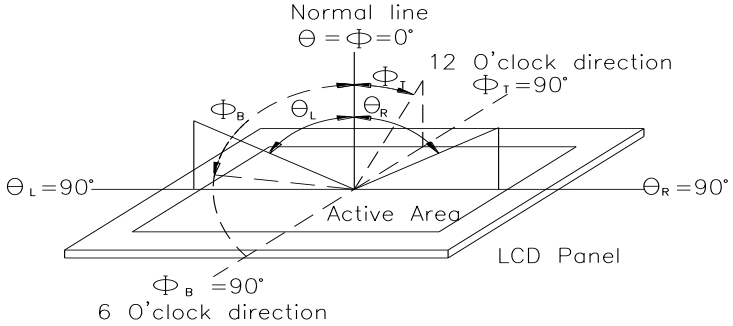


Fig.9.1. Definition of viewing angle

Note 2: Test equipment setup:

After stabilizing and leaving the panel alone at a driven temperature for 10 minutes, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. Optical specifications are measured by Topcon BM-7orBM-5 luminance meter 1.0° field of view at a distance of 50cm and normal direction.

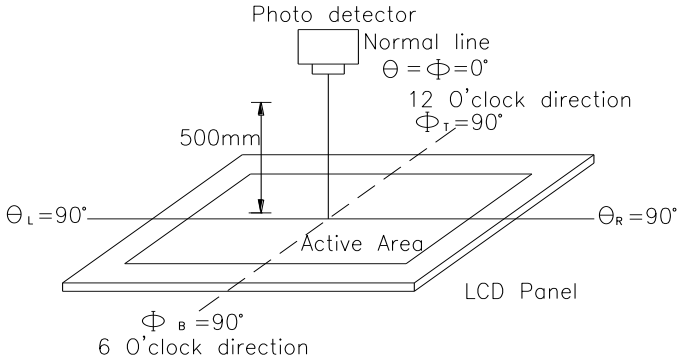
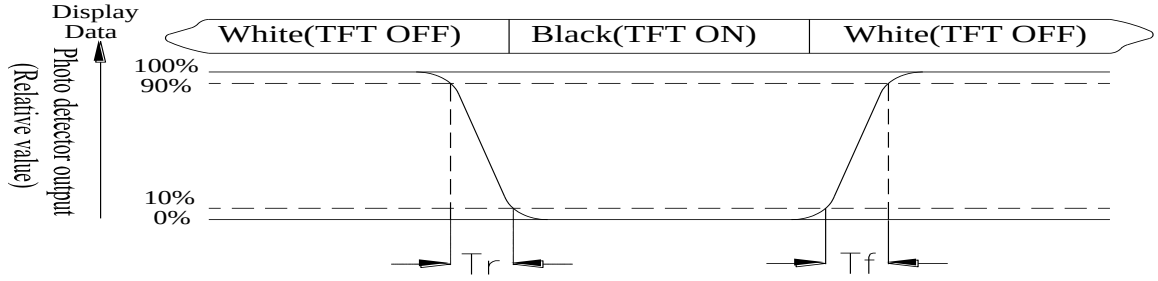


Fig. 9.2. Optical measurement system setup

Note 3: Definition of Response time:
The response time is defined as the LCD optical switching time interval between “White” state and “Black” state. Rise time, Tr, is the time between photo detector output intensity changed from 90%to 10%. And fall time, Tf, is the time between photo detector output intensity changed from 10%to 90%



Note 4: Definition of contrast ratio:
The contrast ratio is defined as the following expression.

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD on the "White" state}}{\text{Luminance measured when LCD on the "Black" state}}$$

Note 5: Definition of Luminance Uniformity
Active area is divided into 3 measuring areas (reference the picture in below). Every measuring point is placed at the center of each measuring area.
Luminance Uniformity (U) = Lmin/Lmax x100%
L = Active area length
W = Active area width

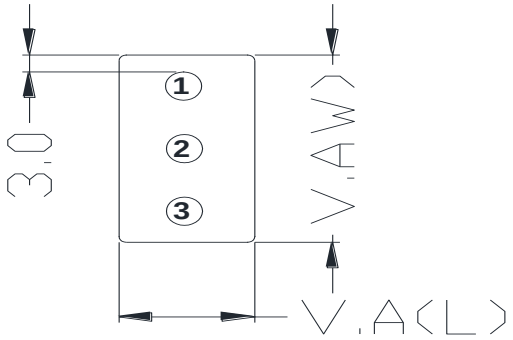


Fig9.3. Definition of uniformity

Note 6: Definition of color chromaticity (CIE 1931)
Color coordinates measured at the center point of LCD

Note 7: Measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

10.Interface

10.1. LCM PIN Definition

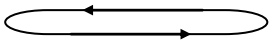
Pin	Symbol	Function	Remark
1	SPI4W	SPI4W='0', 3-wire SPI. SPI4W='1', 4-wire SPI.	
2	NC	No connection	
3	SDA	Serial interface data	
4	SCL	Serial interface clock	
5	RS	Data/command selection pin (4-wire SPI use)	
6	RES	Reset pin (low active)	
7	CS	Chip selection pin (low active)	
8	GND	Ground	
9	NC	No connection	
10	VCC	Power supply.	
11	VLED-	Back light cathode	
12	VLED+	Back light anode	
13	GND	Ground	

10.2. CTP PIN Definition

Pin	Symbol	Function	Remark
1	VDDT	Power supply	
2	SCL	IIC clock signal. Must be pulled high	
3	SDA	IIC data signal. Must be pulled high.	
4	INT	External interrupt to the host	
5	RESET	External Reset. Low is active	
6	VSS	Power ground.	

11.Reliability

Content of Reliability Test (Wide temperature, -20℃~70℃)

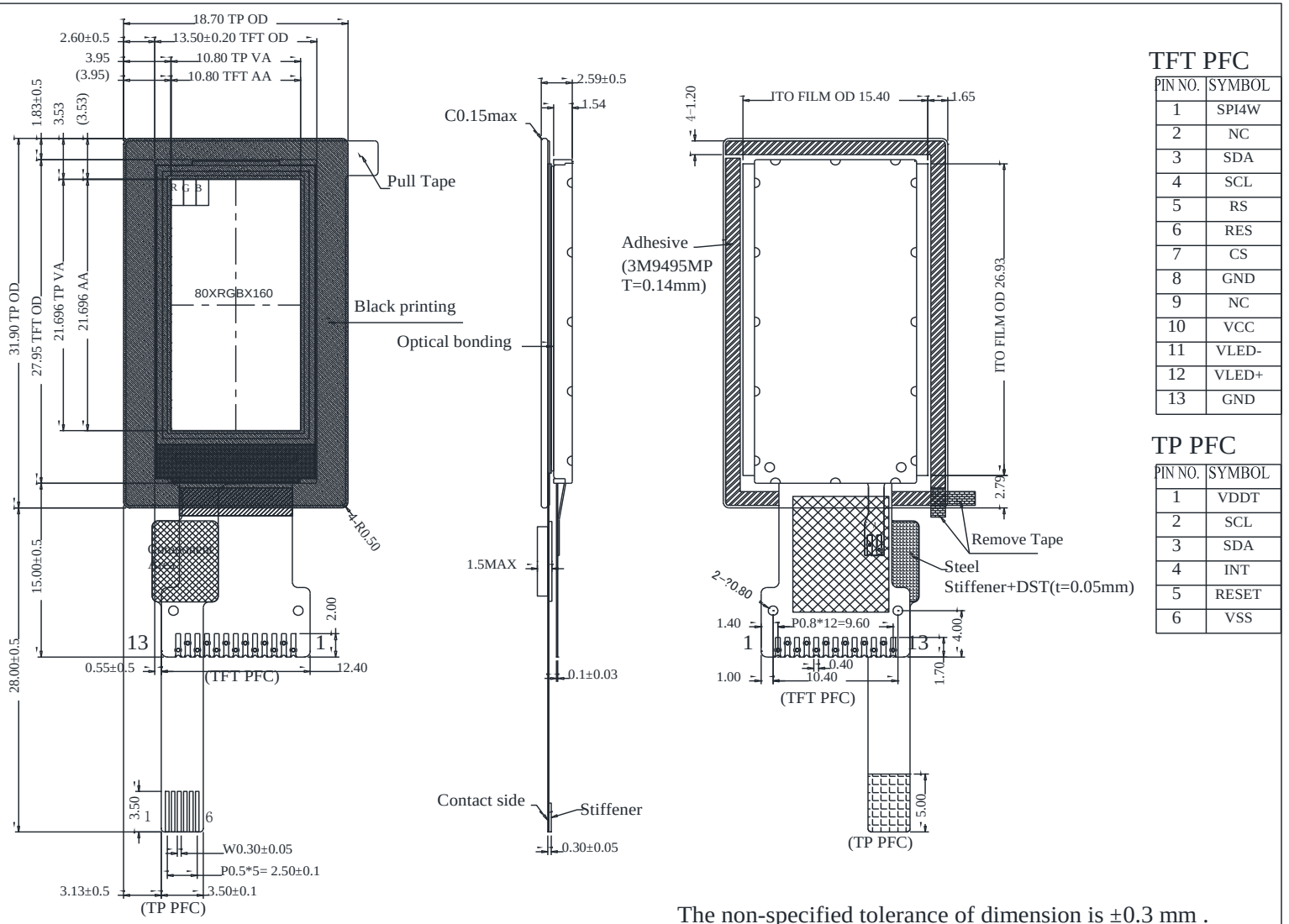
Environmental Test			
Test Item	**Content of Test**	**Test Condition**	**Note**
High Temperature storage	Endurance test applying the high storage temperature for a long time.	80℃ 200hrs	2
Low Temperature storage	Endurance test applying the low storage temperature for a long time.	-30℃ 200hrs	1,2
High Temperature Operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	70℃ 200hrs	———
Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time.	-20℃ 200hrs	1
High Temperature/ Humidity Operation	The module should be allowed to stand at 60℃,90%RH max	60℃,90%RH 96hrs	1,2
Thermal shock resistance	The sample should be allowed stand the following 10 cycles of operation -20℃ 25℃ 70℃  30min 5min 30min 1 cycle	-20℃/70℃ 10 cycles	———
Vibration test	Endurance test applying the vibration during transportation and using.	Total fixed amplitude : 1.5mm Vibration Frequency : 10~55Hz One cycle 60 seconds to 3 directions of X,Y,Z for Each 15 minutes	3
Static electricity test	Endurance test applying the electric stress to the terminal.	VS=±600V(contact), ±800v(air), RS=330Ω CS=150pF 10 times	———

Note1: No dew condensation to be observed.

Note2: The function test shall be conducted after 4 hours storage at the normal Temperature and humidity after remove from the test chamber.

Note3: The packing have to including into the vibration testing.

12.Contour Drawing



TFT PFC

PIN NO.	SYMBOL
1	SPI4W
2	NC
3	SDA
4	SCL
5	RS
6	RES
7	CS
8	GND
9	NC
10	VCC
11	VLED-
12	VLED+
13	GND

TP PFC

PIN NO.	SYMBOL
1	VDDT
2	SCL
3	SDA
4	INT
5	RESET
6	VSS

The non-specified tolerance of dimension is ±0.3 mm .

13.檢驗規範(Inspection Specification)

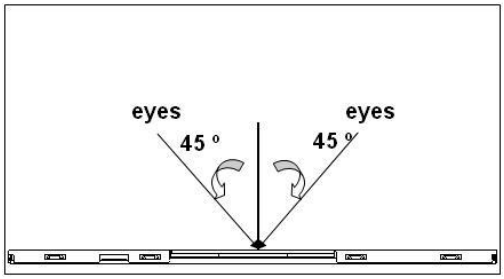
1. 範圍(Scope)：適用於本公司 TFT-LCD 模塊(The document shall be applied to TFT-LCD Module)
2. 檢驗標準(Inspection Standard)：MIL-STD-105E 正常單次抽樣水平 II(MIL-STD-105E Table Normal Inspection Single Sampling Level II)
3. 缺陷水平(Defect Level)：主要缺陷 AQL：0.65;次要缺陷 AQL：2.5(Major Defect AQL:0.65;Minor Defect AQL:2.5)
4. 檢驗條件(Test conditions):

(1)溫度(Temperature)：15℃~25℃；溼度(Humidity)：55 ±15%

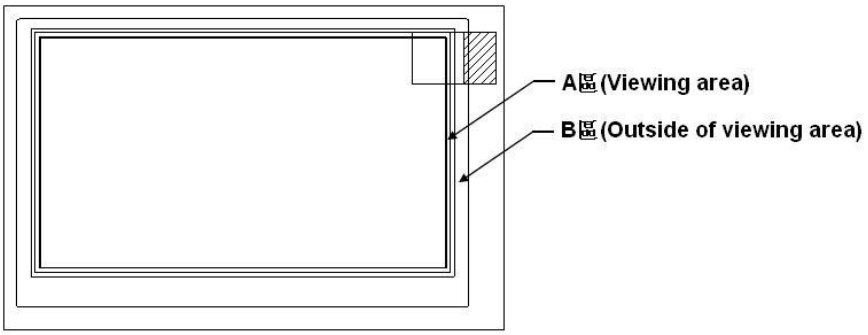
(2)外觀檢驗(Visual inspection)：光照強度：500 Lux 以上;檢查距離：20cm~30cm (Illumination：More than 500 Lux; Inspection Distance: 20cm~30cm)

(3)電性檢驗(Electrical inspection)：光照強度：100Lux~300Lux;檢查距離：20cm~30cm(Illumination：100Lux~300Lux; Inspection Distance: 20cm~30cm)

(4)目視角度(Visual angle)：檢查目視的角度是法線方法的 45 º(The test direction is base on about around 45º of Vertical line）



(5)定義區域(Definition of area):



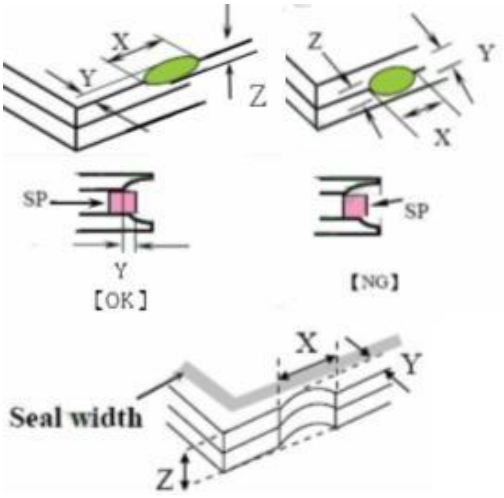
5. 象素定義 (Pixel Definition):

R	G	B	R	G	B	R	G	B		Dot Defect
R	G	B	R	G	B	R	G	B		Adjacent Dot Defect
R	G	B	R	G	B	R	G	B		Cluster

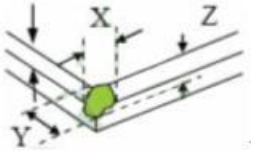
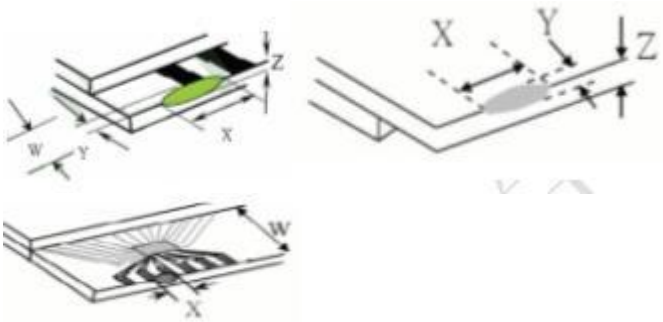
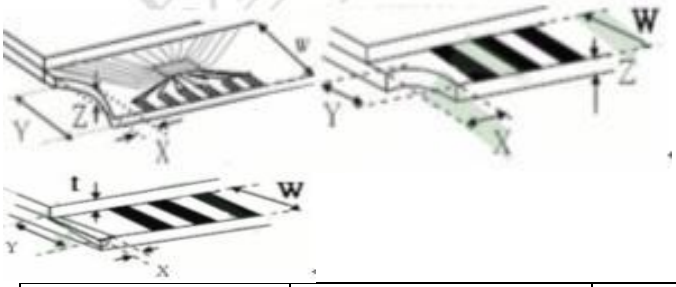
Note 1:If pixel or partial sub-pixel defects exceed 50% of the affected pixel or sub-pixel area, it shall be considered as1 defect.

Note 2: There should be no distinct non-uniformity visible through 6% ND Filter within 2 sec inspection times.

5. 檢驗標準(Inspection Standard)：

<table>
<tr><th>項次
(No)</th><th>檢驗項目(Inspection item)</th><th>檢驗標準(Inspection Standard)</th><th>缺陷等級
(Defect Level)</th></tr>
<tr><td>1</td><td>PACKING
&INDICATE</td><td>1.1.不可有混入其他型號產品的現象(Mixde product types).
1.2.不可有產品漏工序的現象(The part number is inconsistent with work order of production).
1.3.不可有部件裝反方向的現象(Assembled in inverse direction).
1.4.不可有數量與實際要求不一致的現象(The quantity is inconsistent with work order of production).</td><td>主缺
(Maj)</td></tr>
<tr><td>2</td><td>尺寸(Size)</td><td>产品尺寸和结构必须符合结构图(Product size and structure must meet the structure diagram)</td><td>主缺
(Maj)</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">玻璃裂纹(The crack of glass)</td><td>符號(Symbols):
X:破裂長度(Symbols)
Y:破裂寬度(The width of crack).
Z:破裂厚度(The thickness of crack).
W:出電極區寬度(Terminal length)
T:玻璃厚度(The thickness of glass).
a:LCD 側面長度(LCD side length).</td><td rowspan="2">次缺
(Min)</td></tr>
<tr><td>3.1.一般玻璃破損(General glass chip):
3.1.1.玻璃表面或上、下玻璃組合縫隙之間破損(Chip on panel surface and crack between panels);
 

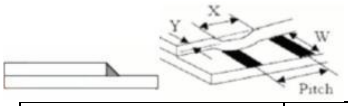
<table>
<tr><th>X</th><th>Y</th><th>Z</th></tr>
<tr><td>≤a</td><td>裂紋進入 VA 區(Crack can't enter viewing area)</td><td>≤1/2t</td></tr>
<tr><td>≤a</td><td>裂紋超過 SP 一半的寬度(Crack can't exceed the half of SP width)</td><td>1/2t＜Z≤2t</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td></td><td>3.1.2.邊角破損(Corner crack)：
 
</td><td></td></tr>
<tr><td>項次
(No)</td><td>檢驗項目(Inspection item)</td><td>檢驗標準(Inspection Standard)</td><td>缺陷等級
(Defect Level)</td></tr>
<tr><td>3</td><td>玻璃裂纹(The crack of glass)</td><td>
<table>
<tr><td>X</td><td>Y</td><td>Z</td></tr>
<tr><td>≤1/5a</td><td>裂紋進入 VA 區(Crack can't enter viewing area)</td><td>≤1/2t</td></tr>
<tr><td>≤1/5a</td><td>裂紋超過 SP 一半的寬度(Crack can't exceed the half of SP width)</td><td>1/2t＜Z≤2t</td></tr>
</table>
3.2.出电极端破损(Protrusion over terminal):
3.2.1.电极垫上破损(Chip on electrode pad):
 
<table>
<tr><td>位置(Position)</td><td>X</td><td>Y</td><td>Z</td></tr>
<tr><td>正面(Front)</td><td>≤a</td><td>≤1/2W</td><td>≤t</td></tr>
<tr><td>背面(Back)</td><td>≤a</td><td>≤W</td><td>≤1/2t</td></tr>
</table>
3.2.2.出電極端非電極破損(Non-conductive portion):
 
<table>
<tr><td>X</td><td>Y</td><td>Z</td></tr>
<tr><td>≤1/3a</td><td>≤W</td><td>≤t</td></tr>
</table>
</td><td>次缺
(Min)</td></tr>
</table>

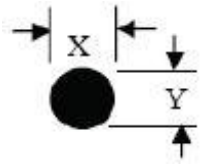
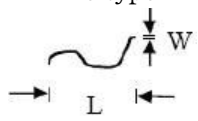
備註(Note)：

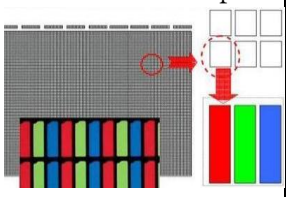
如果破碎部分触及 ITO 電極則不可超過 ITO 電極寬度的 1/3，且必須進行通電測試，不可影響顯示效果
(If the chipped area touches the ITO terminal,over 2/3 of the ITO must remain and be inspected according to electrode terminal specifications).

3.2.3.玻璃破損(Glass remain)：



X	Y	Z
≤a	≤1/3W	≤t

項次 (No)	檢驗項目(Inspection item)	檢驗標準(Inspection Standard)	缺陷等級 (Defect Level)
4	黑點、白點異物 (Black or white dot)Round type 	4.1 Round type(Non-display or display): 尺寸(Size) / 判定標準(Judging standard) / 允收數量(Acceptance(Q'ty)) 0.96”: D ≤0.1 mm — 忽略不計(Ignore) 0.96”: 0.10mm < D ≤ 0.4mm — N≦3 0.96”: D > 0.4mm — N≦0 distance >=5mm	次缺 (Min)
5	刮痕、線狀異物 (scratch、contamination) Line type 	5.1 Line type(Non-display or display): 尺寸(Size) / 判定標準(Judging standard) W / L / 允收數量(Acceptance(Q'ty)) 0.96”: W≦ 0.03mm — — 忽略不計(Ignore) 0.96”: 0.03mm＜W≦0.05mm — L ≦ 5mm — N≦4 0.96”: W ＞ 0.05mm — L ＞ 5mm — N≦0 distance >=5mm	次缺 (Min)
6	POL 氣泡(Polarizer Bubble)	視區(area) / 判定標準(Judging standard) / 允收數量(Acceptance(Q'ty)) A 區(Viewing area): D < 0.2 mm — 忽略不計(Ignore) A 區(Viewing area): 0.2mm＜D≦0.3mm — N≦3 A 區(Viewing area): 0.3mm＜D≦0.5mm — N≦1	次缺 (Min)

<table>
<tr><td></td><td></td><td>
<table>
<tr><td></td><td>0.5mm＜D</td><td>N≦0</td></tr>
<tr><td>B 區(Outside of viewing area)</td><td>_</td><td>忽略不計(Ignore)</td></tr>
</table>
</td><td></td></tr>
<tr><td>項次(No)</td><td>檢驗項目(Inspection item)</td><td>檢驗標準(Inspection Standard)</td><td>缺陷等級(Defect Level)</td></tr>
<tr><td>7</td><td>POL 折痕&分層(The folding and peeled offin polarizer)</td><td>偏光片不可有折痕和分層（脫膠）的現象(The folding and peeled offin polarizer are not acceptable).</td><td>次缺(Min)</td></tr>
<tr><td>8</td><td>輝度及均勻性、色度(Brightness and uniformity、Chroma)</td><td>應符合規範或圖紙要求規格(Shall be in accordance with the drawings and specification requirements specifications).</td><td>主缺(Maj)</td></tr>
<tr><td>9</td><td>MURA</td><td>(5% ND Filter)灰階 50%</td><td></td></tr>
<tr><td>10</td><td>電性測試（Electrlcal Testing）</td><td>1.顯示缺畫(Missing line character and icon).
2.無功能與無顯示(No function or no display).
3.顯示故障(Display malfunction).
4.LCD 視角缺陷(LCD viewing angle defect).
5.消耗電流超出規格(Current consumption exceeds product specifications).</td><td>主缺(Maj)</td></tr>
<tr><td>11</td><td>亮點、暗點(Bright dot、Dark dot)On-display
Pixel：3 dot in 1 pixel
  </td><td>
<table>
<tr><td>尺寸(Size)</td><td>Item</td><td>判定標準(Judging standard)</td><td>允收數量(Acceptance(Q'ty))</td></tr>
<tr><td rowspan="5">0.96”</td><td rowspan="2">Bright dot</td><td>D≦1/2 Dot</td><td>忽略不計(Ignore)</td></tr>
<tr><td>1/2 Dot＜D≦1 Dot</td><td>N≦1</td></tr>
<tr><td rowspan="2">Dark dot</td><td>D≦1/2 Dot</td><td>忽略不計(Ignore)</td></tr>
<tr><td>1/2 Dot＜D≦1 Dot</td><td>N≦2</td></tr>
<tr><td colspan="2">Total</td><td>N≦2</td></tr>
</table>
Dark and bright dot is defined more than 50% area of one dot.
</td><td>次缺(Min)</td></tr>
</table>

14.Initial Code for Reference

```
GATE = 160;
SOURCE = 80;

//RESET
SPI_RST = 1;                                        //RA0
delay1(10);
SPI_RST = 0;
delay1(1000);
SPI_RST = 1;
delay1(10);

//20180302 Brian add
//Sleep out
SPI_WF0096A_WrCmd(0x11);                            //Sleep out
delay(120);

//ST7735S Frame Rate Setting in normal mode: fosc/
(((RTNA*2)+40)*(LINE+FPA+BPA+2))=80
  SPI_WF0096A_WrCmd(0XB1);                          // fosc=850KHz
SPI_WF0096A_WriteData(0X05);                        // RTNA=5
SPI_WF0096A_WriteData(0X3C);   //20180612           // FPA=58
SPI_WF0096A_WriteData(0X3C);   //20180612           // BPA=58

//ST7735S Frame Rate Setting in idle mode: fosc/ (((RTNB*2)+40)*(LINE+FPB+BPB+2))=80
  SPI_WF0096A_WrCmd(0XB2);                          // fosc=850KHz
SPI_WF0096A_WriteData(0X05);                        // RTNB=5
SPI_WF0096A_WriteData(0X3C);    //20180612          // FPB=58
SPI_WF0096A_WriteData(0X3C);    //20180612          // BPB=58

//ST7735S Frame Rate Setting in parital mode (dot inverson): fosc/
(((RTNC*2)+40)*(LINE+FPC+BPC+2))=80
//ST7735S Frame Rate Setting in parital mode (column inverson): fosc/
(((RTNC*2)+40)*(LINE+FPC+BPC+2))=80
SPI_WF0096A_WrCmd(0XB3);                            // fosc=850KHz
SPI_WF0096A_WriteData(0X05);                        // RTNC=5
SPI_WF0096A_WriteData(0X3C);    //20180612          // FPC=58
SPI_WF0096A_WriteData(0X3C);    //20180612          // BPC=58
SPI_WF0096A_WriteData(0X05);                        // RTND=5
SPI_WF0096A_WriteData(0X3C);    //20180612          // FPD=58
SPI_WF0096A_WriteData(0X3C);    //20180612          // BPD=58

//ST7735S Display Inversion Control
SPI_WF0096A_WrCmd(0XB4);                            // Dot inversion: 20184019
modify from Sitronix initial code
SPI_WF0096A_WriteData(0X07);                        // 0xB4[2]=Inversion setting in
normal mode
                                                    // 0xB4[1]=Inversion setting in
idle mode
```

```
                                                        // 0xB4[0]=Inversion setting in
partial mode


//ST7735S Power on Sequence
SPI_WF0096A_WrCmd(0XC0);                                // power control 1
SPI_WF0096A_WriteData(0XE9);     //20180612                    //
{Par.3[0],Par.1[4:0]}=VRHP[5:0]=2→GVDD=4.6, Par.1[7:5]=AVDD [2:0]=6→AVDD=5.1
SPI_WF0096A_WriteData(0X09);      //20180612                   //
{Par.3[1],Par.2[4:0]}=VRHN[5:0]=2→GVCL=-4.6
SPI_WF0096A_WriteData(0X04);                            // Par.3[7:6]=MODE[1:0]=2X

SPI_WF0096A_WrCmd(0XC1);                                // power control 2
SPI_WF0096A_WriteData(0XC5);     //20180612                   // Par.1
[1:0]=VGHBT[1:0]=0→VGH=2*AVDD+VGH25-0.5
                                                        // Par.1
[3:2]=VGLSEL[1:0]=0→VGL=-7.5
                                                        // Par.1
[7:6]=VGLSEL[1:0]=3→VGH25=2.4

SPI_WF0096A_WrCmd(0XC2);                                // power control 3
SPI_WF0096A_WriteData(0X0D);    //20180612                    // (Sitronix initial)
{Par.1 [7:6],Par.2[7:0]=DCA[9:0]=000000000'b→Booster set up cycle BCLK/1 BCLK/3 BCLK/1
BCLK/1 BCLK/1 in normal mode
SPI_WF0096A_WriteData(0X00);                            // Par.1[5:3]=SAPA[2:0]=001'b→
OP current is small in normal mode
                                                        // Par.1[2:0]=APA[2:0]=001'b→
OP current is Large in normal mode

SPI_WF0096A_WrCmd(0XC3);                                // power control 4
SPI_WF0096A_WriteData(0X8D); //20180612                    // (Sitronix
initial){Par.1 [7:6],Par.2[7:0]=DCB[9:0]=1001101010'b→Booster set up cycle BCLK/2 BCLK/1
BCLK/2 BCLK/2 BCLK/2 in idle mode
SPI_WF0096A_WriteData(0X6A);                            // Par.1[5:3]=SAPB[2:0]=001'b→
OP current is small in idle mode
                                                        // Par.1[2:0]=APB[2:0]=011'b→
OP current is Medium in idle mode

SPI_WF0096A_WrCmd(0XC4);                                // power control 5
SPI_WF0096A_WriteData(0X8D); //20180612                    // (Sitronix
initial){Par.1 [7:6],Par.2[7:0]=DCC[9:0]=1011101110'b→Booster set up cycle BCLK/2 BCLK/2
BCLK/2 BCLK/4 BCLK/2 in partial mode
SPI_WF0096A_WriteData(0XEE);                            // Par.1[5:3]=SAPC[2:0]=001'b→
OP current is small in partial mode


// ST7735S VCOM
SPI_WF0096A_WrCmd(0XC5);                                // VCOM setting value
SPI_WF0096A_WriteData(0X15); //20180612                    //
0XC5[5:0]=010010'b → VCOM=-0.875
```

```
// ST7735 Memory data access control: add from Sitronix initial code
SPI_WF0096A_WrCmd(0X36);                                    // VCOM setting value
SPI_WF0096A_WriteData(0XC8);
//ST7735 Display Inversion on
SPI_WF0096A_WrCmd(0X21);


// ST7735 Gamma Sequence
SPI_WF0096A_WrCmd(0XE0);                                    // Gamma setting value
(Positive Polarity)
SPI_WF0096A_WriteData(0X07);    //20180612                  //
Par.1[5:0]=VRF0P[5:0]=000011'b (Variable Resistor VRHP)
SPI_WF0096A_WriteData(0X0E);     //20180612                 //
Par.2[5:0]=VOS0P[5:0]=011011'b (Variable Resistor VRLP)
SPI_WF0096A_WriteData(0X08);    //20180612                  //
Par.3[5:0]=PK0P[5:0]=010010'b    (Voltage of V3 grayscale)
SPI_WF0096A_WriteData(0X07);    //20180612                  //
Par.4[5:0]=PK1P[5:0]=010001'b    (Voltage of V4 grayscale)
SPI_WF0096A_WriteData(0X10);     //20180612                   //
Par.5[5:0]=PK2P[5:0]=111111'b    (Voltage of V12 grayscale)
SPI_WF0096A_WriteData(0X07);    //20180612                  //
Par.6[5:0]=PK3P[5:0]=111010'b    (Voltage of V20 grayscale)
SPI_WF0096A_WriteData(0X02);    //20180612                  //
Par.7[5:0]=PK4P[5:0]=111010'b    (Voltage of V28 grayscale)
SPI_WF0096A_WriteData(0X07);    //20180612                  //
Par.8[5:0]=PK5P[5:0]=110100'b    (Voltage of V36 grayscale)
SPI_WF0096A_WriteData(0X09);    //20180612                  //
Par.9[5:0]=PK6P[5:0]=101111'b    (Voltage of V44 grayscale)
SPI_WF0096A_WriteData(0X0F);    //20180612                   //
Par.10[5:0]=PK7P[5:0]=101011'b    (Voltage of V52 grayscale)
SPI_WF0096A_WriteData(0X25);    //20180612                   //
Par.11[5:0]=PK8P[5:0]=110000'b    (Voltage of V56 grayscale)
SPI_WF0096A_WriteData(0X36);    //20180612                  //
Par.12[5:0]=PK9P[5:0]=111010'b    (Voltage of V60 grayscale)
SPI_WF0096A_WriteData(0X00);                              //
Par.13[5:0]=SELV0P[5:0]=000000'b    (Voltage of V0 grayscale)
SPI_WF0096A_WriteData(0X08);    //20180612                  //
Par.14[5:0]=SELV1P[5:0]=000001'b    (Voltage of V1 grayscale)
SPI_WF0096A_WriteData(0X04);     //20180612                   //
Par.15[5:0]=SELV62P[5:0]=000010'b    (Voltage of V62 grayscale)
SPI_WF0096A_WriteData(0X10);    //20180612                  //
Par.16[5:0]=SELV63P[5:0]=001001'b    (Voltage of V63 grayscale)


SPI_WF0096A_WrCmd(0XE1);                                    // Gamma setting value
(Negative Polarity)
SPI_WF0096A_WriteData(0X0A);    //20180612                  //
Par.1[5:0]=VRF0N[5:0]=000011'b (Variable Resistor VRHN)
SPI_WF0096A_WriteData(0X0D);     //20180612                 //
```

```
Par.2[5:0]=VOS0N[5:0]=011011'b (Variable Resistor VRLN)
SPI_WF0096A_WriteData(0X08);    //20180612                    //
Par.3[5:0]=PK0N[5:0]=010010'b    (Voltage of V3 grayscale)
SPI_WF0096A_WriteData(0X07);    //20180612                    //
Par.4[5:0]=PK1N[5:0]=010001'b    (Voltage of V4 grayscale)
SPI_WF0096A_WriteData(0X0F);    //20180612                      //
Par.5[5:0]=PK2N[5:0]=110010'b    (Voltage of V12 grayscale)
SPI_WF0096A_WriteData(0X07);    //20180612                    //
Par.6[5:0]=PK3N[5:0]=101111'b    (Voltage of V20 grayscale)
SPI_WF0096A_WriteData(0X02);    //20180612                    //
Par.7[5:0]=PK4N[5:0]=101010'b    (Voltage of V28 grayscale)
SPI_WF0096A_WriteData(0X07);    //20180612                    //
Par.8[5:0]=PK5N[5:0]=101111'b    (Voltage of V36 grayscale)
SPI_WF0096A_WriteData(0X09);    //20180612                    //
Par.9[5:0]=PK6N[5:0]=101110'b    (Voltage of V44 grayscale)
SPI_WF0096A_WriteData(0X0F);    //20180612                      //
Par.10[5:0]=PK7N[5:0]=101100'b    (Voltage of V52 grayscale)
SPI_WF0096A_WriteData(0X25);    //20180612                      //
Par.11[5:0]=PK8N[5:0]=111001'b    (Voltage of V56 grayscale)
SPI_WF0096A_WriteData(0X35);                                    //
Par.12[5:0]=PK9N[5:0]=111111'b    (Voltage of V60 grayscale)
SPI_WF0096A_WriteData(0X00);                                    //
Par.13[5:0]=SELV0N[5:0]=000000'b    (Voltage of V0 grayscale)
SPI_WF0096A_WriteData(0X09);    //20180612                    //
Par.14[5:0]=SELV1N[5:0]=000000'b    (Voltage of V1 grayscale)
SPI_WF0096A_WriteData(0X04);    //20180612                      //
Par.15[5:0]=SELV62N[5:0]=000001'b    (Voltage of V62 grayscale)
SPI_WF0096A_WriteData(0X10);    //20180612                    //
Par.16[5:0]=SELV63N[5:0]=001001'b    (Voltage of V63 grayscale)

SPI_WF0096A_WrCmd(0XFC);                                        // Enable Gate power save
mode
SPI_WF0096A_WriteData(0XC0);                                    //
0XFC[7:6]=GCV_Enable[1:0]=10'b→ Gate Pump Clock Frequency disable
                                                                //
0XFC[3:2]=CLK_Variable[1:0]=11'b→ Save Power Ability is Large
SPI_WF0096A_WrCmd(0X3A);
SPI_WF0096A_WriteData(0X05);                                    // 65K Mode

SPI_WF0096A_WrCmd(0X2A);
SPI_WF0096A_WriteData(0X00);                                    // 65K Mode
SPI_WF0096A_WriteData(0X1A);                                    // 65K Mode
SPI_WF0096A_WriteData(0X00);                                    // 65K Mode
SPI_WF0096A_WriteData(0X69);                                    // 65K Mode

SPI_WF0096A_WrCmd(0X2B);
SPI_WF0096A_WriteData(0X00);                                    // 6
SPI_WF0096A_WriteData(0X01);                                    //
SPI_WF0096A_WriteData(0X00);                                    //
SPI_WF0096A_WriteData(0XA0);                                    //
```

```
SPI_WF0096A_WrCmd(0X29);                    // Display on
```

winstar

LCM Sample Estimate Feedback Sheet

Module Number： _____

1、Panel Specification：

1. Panel Type： □ Pass □ NG ,_____
2. View Direction： □ Pass □ NG ,_____
3. Numbers of Dots： □ Pass □ NG ,_____
4. View Area： □ Pass □ NG ,_____
5. Active Area： □ Pass □ NG ,_____
6. Operating Temperature： □ Pass □ NG ,_____
7. Storage Temperature： □ Pass □ NG ,_____
8. Others：_____

2、Mechanical Specification：

1. PCB Size： □ Pass □ NG ,_____
2. Frame Size： □ Pass □ NG ,_____
3. Material of Frame： □ Pass □ NG ,_____
4. Connector Position： □ Pass □ NG ,_____
5. Fix Hole Position： □ Pass □ NG ,_____
6. Backlight Position： □ Pass □ NG ,_____
7. Thickness of PCB： □ Pass □ NG ,_____
8. Height of Frame to PCB： □ Pass □ NG ,_____
9. Height of Module： □ Pass □ NG ,_____
10. Others： □ Pass □ NG ,_____

3、Relative Hole Size：

1. Pitch of Connector： □ Pass □ NG ,_____
2. Hole size of Connector： □ Pass □ NG ,_____
3. Mounting Hole size： □ Pass □ NG ,_____
4. Mounting Hole Type： □ Pass □ NG ,_____
5. Others： □ Pass □ NG ,_____

4、Backlight Specification：

1. B/L Type： □ Pass □ NG ,_____
2. B/L Color： □ Pass □ NG ,_____
3. B/L Driving Voltage (Reference for LED Type)： □ Pass □ NG ,_____
4. B/L Driving Current： □ Pass □ NG ,_____
5. Brightness of B/L： □ Pass □ NG ,_____
6. B/L Solder Method： □ Pass □ NG ,_____
7. Others： □ Pass □ NG ,_____

>> **Go to page 2** <<

5、Electronic Characteristics of Module：

1.	Input Voltage：	□ Pass	□ NG ,_____
2.	Supply Current：	□ Pass	□ NG ,_____
3.	Driving Voltage for LCD：	□ Pass	□ NG ,_____
4.	Contrast for LCD：	□ Pass	□ NG ,_____
5.	B/L Driving Method：	□ Pass	□ NG ,_____
6.	Negative Voltage Output：	□ Pass	□ NG ,_____
7.	Interface Function：	□ Pass	□ NG ,_____
8.	LCD Uniformity：	□ Pass	□ NG ,_____
9.	ESD test：	□ Pass	□ NG ,_____
10.	Others：	□ Pass	□ NG ,_____

6、Summary：

Sales signature：_____

Customer Signature：_____ **Date**：____/____/____